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(54) CONTROL DEVICE

(71) We, U.M. ELECTRICAL DISTRIBUTORS LIMITED, a British company, of Banbury Industrial Estate, Beaumont Road, Banbury, Oxon, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to control devices and, although not so restricted, will be described with reference to its use in connection with an anti-theft device for a mechanically powered vehicle.

According to one aspect of the present invention there is provided a control device for activating electrical apparatus comprising: first producing means for producing a first activating signal for causing the apparatus to be activated when the control device is in an armed condition; second producing means for producing a second activating signal for causing the apparatus to be activated when the control device is in the armed condition; latch means which are such that when the control device is in the armed condition the latch means are in a first (armed) state and when the control device is in a disarmed condition, in which the apparatus cannot be activated, the latch means are in a second (disarmed) state; means for causing the latch means to change between armed and disarmed states; timing means for causing the latch means to change from the disarmed state to the armed state after a predetermined time if no first activating signal is produced by the first producing means and/or no second activating signal is produced by the second producing means; and bistable logic means which change from a first state to a second state if the second activating signal is applied thereto whilst the latch means are in the disarmed state, the arrangement being such that when the bistable logic means are in the second state and the latch means are in a disarmed state, the control device remains in the disarmed condition until the latch means is armed by the onset and termination of a first activating signal from the first producing means, this action re-arming the control device.

The latch means may include two NAND gates connected to operate in a bistable flip-flop mode.

Preferably, the timing means comprises a capacitor and resistor arrangement.

Said bistable logic means may include two further NAND gates connected to operate in a bistable flip-flop mode.

The control device may include further timing means for causing said apparatus to remain activated for a predetermined time after the first and/or second activating signal has ceased.

In the preferred embodiment, the first and second producing means each include a light sensitive means for causing the respective first and second activating signals in response to light incident thereon.

According to another aspect of the present invention, there is provided an anti-theft device for a mechanically powered vehicle including a control device as recited above in combination with the electrical apparatus, e.g. a relay, to be activated thereby.

The invention is illustrated, merely by way of example, in the accompanying drawing which is a circuit diagram of a control device according to the present invention.

The control device illustrated in the drawing is suitable for use as an anti-theft device for a mechanically powered vehicle and it will be described in connection with such use. It will, however, be appreciated that the control device has other uses such as, for example, in connection with the protection of buildings or safes.

The control device has a two-pole ganged arming switch SW1 which disarms the control device. As illustrated in the drawing, the switch is in a first position and remains in this position except when the control device is to be disarmed by momentarily reversing the position. In this first position a rail 10 is connected to a supply 11 through a line 12, a diode bridge B1 and a line 13. The purpose of the diode bridge B1 is to prevent a voltage of reverse polarity from being applied to any of the components of the circuit.

An electrolytic capacitor C1 is connected

in series with a diode D3 in a line 16 extending between a ground rail 14 and a line 15. Rail 14 is connected to ground *via* bridge B1. The line 15 is connected to the line 13 through the switch SW1 and a resistor R7. In the first position of the switch SW1 the line 15 is broken. The output of a NAND gate 1 is connected to the line 16 *via* a diode D1, and the output of a NAND gate 3 is connected directly to the line 16 *via* diode D2. A NAND gate 2 is connected with the gate 3 to operate in a bistable flip-flop mode.

A NAND gate is a logic gate having two inputs and one output. When the inputs are both of positive voltage or open-circuited (herein designated +1) the gate is OFF, i.e. its output is zero (herein +0), with all other combinations of inputs (i.e. +1+0, +0+1, +0+0) the gate is ON and the output is +1.

A first input to the gate 1 is connected to the rail 10. The second input of the gate 1 is connected to one side of a light sensitive transistor LST1 the other side of which is connected to the rail 14. The transistor LST1 may receive light from a bulb LP1 in a line 17 extending between an alarm set-off switch SW2 only one contact of which is shown in the drawing. The line 17 has a resistor R1 therein and is connected at its other end to the line 12. When the set-off switch is closed current flows from the supply 11 through the line 17 and the resistor R1 and lights the bulb. The purpose of the resistor R1 is to reduce the temperature of the filament of the bulb LP1 to increase its life and to prevent it burning out as a result of transient peaks in the supply 11.

The first output of the gate 2 is connected to the second input of the gate 1. The output of the gate 2 is connected to the first input of the gate 3 and the output of the gate 3 is connected to the second input of the gate 2. The output of the gate 3 is connected *via* a diode D2 to the line 16. The second input of the gate 3 is connected to a first input of a NAND gate 4 and to a light sensitive transistor LST2. The second input of the gate 4 is connected *via* a line 20 to the second input of the gate 1.

The transistor LST2 receives light from a bulb LP2 in a line 21 extending between an ignition switch SW3 of the vehicle (only one contact of which is shown in the drawing) and a line 22 which is grounded *via* a rail 23. A resistor R2 is provided in the line 21 for the same reason as the resistor R1 is provided in the line 17. The switch SW3 is connected by a line 24 to a switch SW4 which, when it and the switch SW3 are both closed, allows current to flow to an ignition coil (not shown) of the vehicle.

The diode D2 is connected *via* a variable resistor VR1 to a two-stage transistor switch 25 consisting of a transistor T1, a transistor T2 and a resistor R4 connected as shown in the drawing.

The output of the switch 25 is connected to a first input of a NAND gate 6 which is connected to a NAND gate 7 to operate in a bistable flip-flop mode. Thus, the second input of the gate 6 is connected to the output of the gate 7. The second input of the gate 7 is permanently connected to the rail 10. The output of the gate 6 and the first input of the gate 7 are connected to a line 26 which, in turn, connects with a first input of a NAND gate 5 the second input of which is connected to the output of the gate 4. Between the line 26 and the rail 14 a resistor R6 and an electrolytic capacitor C2 are connected in parallel.

The output of the gate 5 is connected to the first and second inputs of a NAND gate 8 and thus when gate 5 is ON gate 8 is OFF and *vice versa*. The output of the gate 8 is connected to the base of a transistor T3 the emitter of which is connected by a line 27 to the rail 14. The collector of the transistor T3 is connected to the rail 10 *via* a relay RL1 which is ganged to move the switch SW4, and also a changeover switch SW6, a switch SW7 and a switch SW8.

When the relay is energised the switch SW4 opens to prevent current flowing to the ignition coil (not shown) of the vehicle; the switch SW6 changes from the first position shown in the drawing in which current flows to a timing circuit 28, to charge the capacitor C4, to a second position this circuit being described hereinafter; the switch SW8 closes and current flows through a flasher unit 30 to line 31 connected with a vehicle horn or other alarm (also not shown). As the switch SW8 closes the switch SW7 closes, switching ON the flasher unit 30.

The timing circuit 28 comprises a pair of transistors T4, T5 connected as a Darlington pair. The base of the transistor T5 is connected *via* a resistor R8 to a line 32 in which is a diode D9 and a capacitor C4. When the switch SW6 is in the first position current flows to charge up the capacitor C4. When the switch SW6 changes from the first position to the second position the capacitor C4 commences to discharge through the resistor R8 and transistors T4 and T5 to maintain the relay RL1 energised after the transistor T3 has gone into the non-conducting state, for a time determined by the value of the capacitor C4, the value of the resistor R8 and the gain of the pair of transistors T4 and T5. The purpose of the diode D9 is to prevent the capacitor C4 discharging to rail 10 through transistor T3 when it initially goes into the conducting state. A diode D4 is connected in parallel with the relay RL1 to prevent damage to transistor T3 when the relay RL1 is de-energised.

The various conditions of the control device will now be described.

The first condition is the armed condition of the control device such as when the vehicle is left unattended. In the armed condition the set-off switch SW2 and the ignition switch SW3 are open and the arming switch SW1 is in the position shown in the drawing. The first input to the gate 1 is, therefore, +1 and the second input from the transistor LST1 which is non-conducting is +1: gate 1 is OFF. The input to gate 2 is +1 and since its output is +1 as a result of the arming condition to be described hereinafter gate 2 is ON and gate 3 is OFF. The first input to gate 4 is +1 in view of the fact that it is connected to the transistor LST2 which is non-conducting and the second input is also +1 due to the fact that it is connected to the second input of the gate 1; gate 4 is OFF.

Since gates 1 and 3 are both OFF the first input to the gate 6 si +0. The first input of the gate 7 is +1 because line 26 is +1 because the capacitor C2 is being charged as a result of the arming condition. Consequently, gate 6 is ON and gate 7 is OFF. Similarly, the first input to gate 5 is +1 and, since gate 4 is OFF, the second input thereto is +0. Consequently, gate 5 is ON and gate 8 is OFF. The result is that transistor T3 is in the non-conducting state and the relay RL1 is not energised.

The second condition to be considered is the condition when an unauthorised attempt is made to close the set-off switch SW2 or the ignition switch SW3. For example, the set-off switch SW2 may be positioned adjacent a door (not shown) of the vehicle so that when the door is open the switch closes. As will be appreciated a plurality of set-off switches may be provided in parallel for each door of the vehicle and/or the bonnet and/or the boot.

Firstly let us consider an unauthorised attempt to open the door of the vehicle. When the door of the vehicle is open the bulb LP1 will light and the transistor LST1 will conduct. The second input of the gate 1 will fall to +0 and gates 1 and 4 will go ON and gates 2 and 3 will remain unchanged. As a result of gate 1 going ON current will flow in the line 16 to charge the capacitor C1. The gate 6 is ON and gate 7 is OFF and this state of affairs is maintained even though a current flows through the variable resistor VR1 and the switch 25 to the first input of the gate 6. In view of the fact that gate 4 has gone ON both inputs to gate 5 are +1 so this gate goes OFF and gate 8 goes ON causing the transistor T3 to go into the conducting state energising the relay RL1. Energisation of the relay RL1 causes the switch SW6 to go into the second position, the switch SW4 to open and the switches SW7 and SW8 to close. Thus, the alarm of the vehicle sounds and the vehicle is immobilised because no current can flow to the ignition coil. Furthermore, with the switch SW6 in the second condition the capacitor C4 discharges to its first potential. This condition continues whilst the transistor LST1 conducts, i.e. whilst the door of the vehicle is open.

When the transistor LST1 ceases to conduct, i.e. the door of the vehicle is closed, gates 1 and 4 go OFF and consequently gate 5 goes ON and gate 8 goes OFF. The transistor T3 goes into the non-conducting state, but the relay RL1 is not de-energised because the capacitor C4 discharges to maintain it energised. When the capacitor C4 is sufficiently discharged the relay RL1 is then de-energised and switch SW6 returns to the first position and switches SW4, SW7, SW8 return to the position shown in the drawing. The control device has, therefore, returned to its armed condition. From the above it will be appreciated that the alarm will continue to sound for a time determined by the timing circuit 28 after the switch SW6 has gone into the second position.

If transistor T3 remains in the conducting state after the capacitor C4 has fully discharged, e.g. the door has not been closed, the relay RL1 will remain energised until the door has been closed or the alarm switched off by pulsing the arming switch SW1 as described hereinafter.

It will be appreciated that a similar sequence of events occurs should the transistor LST1 not go into the conductive state when the door is opened, e.g. because of failure of the bulb LP1, and there is unauthorised closure of the ignition switch SW3. In this case the only difference is that the gate 2 goes OFF and the gates 3 and 4 go ON, this time because the transistor LST2 conducts since bulb LP2 will light. It will be appreciated that if transistor LST1 and/or LST2 conduct the gate 5 will go OFF and gate 8 will go ON causing the transistor T3 to go into the conducting state and the relay RL1 to be energised.

The third condition to be considered is that of disarming the control device. To disarm the control device the arming switch SW1 is pulsed, i.e. the line 15 is closed for an instant and at the same time the rail 10 is broken. Whilst the line 15 is closed the capacitor C1 charges up and when rail 10 is broken the capacitor C2 discharges. When line 15 is opened and the rail 10 is closed after the arming switch SW1 has been pulsed gate 6 will be OFF and gate 7 will be ON. Gate 5 is, therefore, ON and gate 8 is OFF so that the transistor T3 is in the non-conductive state. The capacitor C1 begins to discharge, the rate of discharge being dependent upon the value of the variable resis-

tor VR1. The gates 6 and 7 act as a latch and so the output of the gate 6 is +0 until such time as the voltage on the capacitor C1 falls below the threshold voltage of the transistor T1 and the first input of gate 6 is +0 causing it to go ON, the capacitor C2 to charge and gate 7 to go OFF.

If, before the voltage on the capacitor C1 has fallen below the threshold voltage of the transistor T1, the set-off switch SW2 has been closed, e.g. by opening the vehicle door, gates 1 and 4 go ON as described previously and the capacitor C1 is recharged *via* the diode D1. Gate 5 does not go OFF because its first input is still +0 since the capacitor C2 is still discharged which keeps it ON and so the relay will not be energised. If the set-off switch SW2 is then opened, e.g. by closing the vehicle door, the capacitor C1 again begins to discharge through the variable resistor VR1. However, if before the voltage on the capacitor C1 has fallen below the threshold voltage of the transistor T1, the ignition switch SW3 is closed, the gate 2 goes OFF, the gate 3 goes ON, the capacitor C1 recharges and this condition is maintained until the set-off switch SW2 is closed, e.g. by opening the vehicle door.

The final condition is that of arming the control device. When the ignition switch SW3 is opened gate 4 goes OFF and gate 2 is OFF, gate 3 remains ON so that the charge on the capacitor C1 is maintained *via* diode D2. When the set-off switch SW2 is closed, as when the door of the vehicle is opened, this causes bulb LP1 to light, caustransistor LST1 to conduct. When transistor LST1 conducts gate 2 goes ON and gate 3 goes OFF.

When the set-off switch SW2 is opened, as when the door of the vehicle is closed, the bulb LP1 goes out and transistor LST1 ceases to conduct. Because gates 1 and 4 are connected to the transistor LST1, they both go OFF. The capacitor C1 then begins to discharge. When the voltage on the capacitor C1 is below the threshold voltage of the transistor T1, the first input to the gate 6 is +0 and, because the second input to the gate 6 is +1, the output of gate 6 turns line 26 positive, which charges the capacitor C2 and turns gate 7 OFF. Thus the control device returns to the armed condition discussed above.

With the above control device installed in a mechanically powered vehicle as an anti-theft device, a driven would undertake the following sequence of events. On stopping the vehicle the driver would remove an ignition key and open the driver's door which has the set-off switch SW2 associated therewith. If the time constant of the circuit comprising the capacitor C1 and the variable resistor VR1 was, for example, 20 seconds, the device does not arm until 20 seconds after the door has been re-closed. An unauthorised person subsequently approaching the vehicle and opening the door will immediately cause the relay RL1 to be energised sounding the alarm. The immediate reaction will be to close the door but this will not immediately stop the alarm from sounding since the relay RL1 will remain energised by the discharge of the capacitor C4 of the timing circuit 25 which may have a time constant of, for example, 2 minutes. After this 2 minutes has elapsed the control device will return to its armed condition. The purpose of limiting the time for which the alarm sounds after the door has been re-closed is to prevent the battery of the vehicle being run down if no action is taken to silence the alarm. The alarm will sound an intermittent note due to the fact that the flasher unit 30 is connected in series therewith.

The driver of the vehicle on returning to the vehicle uses an external key to pulse of the arming switch SW1 and, assuming that he opens the driver's door before the capacitor C1 has discharged below the threshold voltage of the transistor T1 a time which may, for example, be 20 seconds, the device will remain in its disarmed condition, as long as there is also a delay of less than this time between closing the door and closing the ignition switch SW3.

In vehicle electrical systems it is known for there to be transient peaks in the generated voltage and such transient peaks could damage to various gates. A capacitor C3 is connected in parallel with a zener diode ZD1 between the rail 10 and the rail 14. Any transient peaks cause the capacitor C3 to charge. A resistor R3 is connected between line 15 and rail 14 to act as a potential divider with resistor R7 to bring down the working voltage to approximately the same level as the rail 10. The resistor R5 protects the zener diode ZD1 from current overload.

The control device described above may use integrated circuits and thus, for example, the gates 1 to 4 may be one integrated circuit chip and the gates 5 to 8 may be a second integrated circuit chip.

An "anti-hijack device" may be included. Such a device would include manual means (not shown) for moving the switch SW6 to the second position. Current will, therefore, flow through the relay RL1 as long as the switch SW6 is in the second position and regardless of the state of the transistor T3. Such a device would be useful in, for example, a lorry since the alarm could be sounded by the driver operating the manual means if an attempt were made to hijack the vehicle.

It will be appreciated that the timing circuit 28 may not be required under certain

circumstances in which case a link is taken to line 14 from the second position of the switch SW6 and the relay RL1 will remain energised when the transistor T3 has ceased to conduct. For vehicles having an internal compression ignition engine, the switch SW4 can be connected to an electro-magnetically actuated valve or other electrical means controlling the operation of the engine.

WHAT WE CLAIM IS:—

1. A control device for activating electrical apparatus comprising: first producing means for producing a first activating signal for causing the apparatus to be activated when the control device is in an armed condition; second producing means for producing a second activating signal for causing the apparatus to be activated when the control device is in the armed condition; latch means which are such that when the control device is in the armed condition the latch means are in a first (armed) state and when the control device is in a disarmed condition, in which the apparatus cannot be activated, the latch means are in a second (disarmed) state; means for causing the latch means to change between armed and disarmed states; timing means for causing the latch means to change from the disarmed state to the armed state after a predetermined time if no first activating signal is produced by the first producing means and/or no second activating signal is produced by the second producing means; and bistable logic means which change from a first state to a second state if the second activating signal is applied thereto whilst the latch means are in the disarmed state, the arrangement being such that when the bistable logic means are in the second state and the latch means are in a disarmed state, the control device remains in the disarmed condition until the latch means is armed by the onset and termination of a first activating signal from the first producing means, this action re-arming the control device.

2. A device as claimed in claim 1 in which said latch means includes NAND gates connected to operate in a bistable flip-flop mode.

3. A device as claimed in claim 1 or 2 in which the timing means comprises a capacitor and resistor arrangement.

4. A device as claimed in any preceding claim in which said bistable logic means includes two further NAND gates connected to operate in a bistable flip-flop mode.

5. A device as claimed in any preceding claim including further timing means for causing said apparatus to remain activated for a predetermined time after the first and/or second activating signal has ceased.

6. A device as claimed in any preceding claim in which the first and second producing means each include a light sensitive means for causing the respective first and second activating signals in response to light incident thereon.

7. An anti-theft device for a mechanically powered vehicle including a control device as claimed in any preceding claim in combination with the electrical apparatus to be activated thereby.

8. A device as claimed in claim 7 in which said electrical apparatus is a relay.

9. A control device substantially as herein described with reference to the accompanying drawing.

10. An anti-theft device as claimed in claim 7 and substantially as herein described with reference to the accompanying drawing.

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1404341 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*